BNITM
Bernhard-Nocht-Institut für Tropenmedizin

Global infection research – for the future

2030

Strategy of the Bernhard Nocht Institute for Tropical Medicine

www.bnitm.de/en

125 years at the Port of Hamburg – BNITM expands research for global health.

Infections are a major cause of illness, disability and death worldwide.

Particularly in low-to-middle-income countries, infections can lead to stigmatisation and poverty. We at BNITM are dedicated to making an impact in the fight against infectious diseases through cutting-edge research and in close collaboration with our partners worldwide. To achieve this goal, we place people at the heart of our research, continually evolving our strategy to leverage the latest technological advancements.

The combination of laboratory and field research makes it possible for us to cover the entire translational spectrum: from experimental findings to clinical research in humans and public health interventions in the field.

We take a two-pronged approach: exploring infections and immune responses across multiple scales, from molecular mechanisms to real-world implementation, while also examining the critical role of environmental and social factors in promoting global health.

CONTENTS

I. STRATEGIC TOPICS

1. Innovative analysis of pathogens and interactions with their hosts and vectors

Identifying new preventive and therapeutic targets

- Elucidate pathogen structures and cellular components at highest resolution using advanced biophysical techniques such as cryo-EM, X-ray crystallography and AI-supported analysis methods
- Investigate pathogen functions and interactions in the host through systems biology and computational modelling of living organisms
- Explore vector structures, functions and interactions at the molecular level and the implications for vector competence
- Analyse immune mechanisms, including the effects of vaccine-modulated immunity
- Advance the understanding of resistance and infection mechanisms through comprehensive analyses of genomes, transcriptomes, proteomes, and metabolomes
- Identify targets for vaccines, drugs and diagnostics for poverty-related and neglected tropical diseases (PRNTDs) using artificial intelligence, bioinformatics, and computational modelling
- Reduce animal experimentation by implementing alternative methods such as organoids and organ-on-a-chip systems

2. New approaches to combat infectious diseases

Evaluating new interventions against communicable diseases

- Improve clinical research through innovative intervention studies and adaptive trial designs
- Develop, evaluate, and implement preventative interventions, in particular vaccines
- Further advance digital epidemiology and surveillance for early detection of infection outbreaks as well as integrative and AI-supported control strategies
- Enhance prevention, preparedness, and response strategies for epidemics, taking into account humans, animals and the environment (One Health approach)
- Evaluate and optimise innovative tools and the implementation of control measures for effective disease management

- Develop, validate, and evaluate highly specific and sensitive diagnostic tools to advance control strategies
- Enable rapid and flexible outbreak response through the deployment of mobile laboratories in affected regions
- Analyse the ecology, behaviour, and transmission capacity of vectors in changing environments
- Develop innovative, digitally supported training approaches

3. Pathways to international health in times of change

Discovering new approaches to health and wellbeing

- Study the impact of mobility, migration, urbanisation, and poverty on the spread of infectious diseases
- Analyse the influence of environmental and climate changes on the distribution of pathogens, transmission vectors, and reservoir animals as well as development of mitigation strategies (One Health approaches)
- Investigate the spread of antimicrobial resistance (AMR) through environmental and socio-demographic changes and develop measures to combat it
- Improve preventive measures in health care by integrating epidemiological, socio-demographic, meteorologic and socio-economical data

II. GOALS FOR TROPICAL MEDICINE RESEARCH OF THE FUTURE

For 125 years the **Bernhard Nocht Institute for Tropical Medicine (BNITM)** has been Germany's largest institution for research, diagnostics, care and teaching in the field of tropical, neglected and emerging infections. At the heart of our mission lies our greatest strength: the integration of advanced molecular laboratory research with field studies in areas where tropical diseases are spread. This unique approach enables us to conduct world-class research that improves global strategies in infectious disease control – from molecule to implementation.

Global health is undergoing a rapid and profound transformation: Climate change, increased mobility, inequality and resource scarcity increasingly shape global infection dynamics while the unequal distribution of the disease burden continues to disproportionately affect low- and middle-income countries. Our research agenda responds to this, leveraging revolutionary advances in pathogen structure research, molecular biology, implementation research and computational sciences that are advancing the frontiers of understanding and combating infectious

diseases. In this shifting research environment, the BNITM stands at the forefront as an innovative, interdisciplinary leader with a strong international involvement.

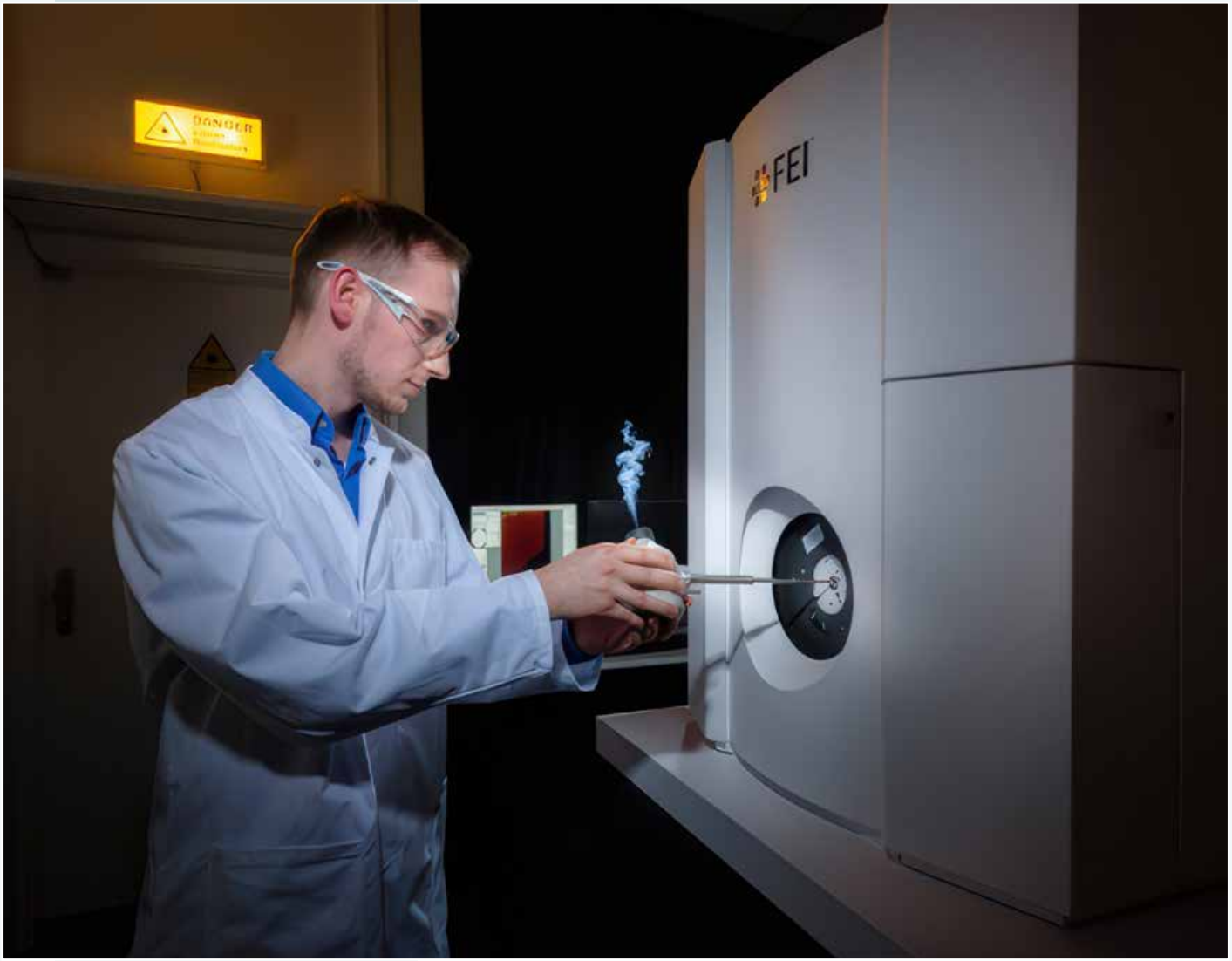
Our future perspective reflects this commitment:

- to decipher smallest structures and multi-layered functions of pathogens from highly infectious viruses to very complex parasites to inform the development of novel drugs, vaccines and diagnostics;
- to use metagenomics, mobile labs and digital tools, including artificial intelligence, to perform robust and informative infectious disease surveillance with all pathogen classes, host animals and in all transmission vectors worldwide (One Health);
- to perform complex epidemiological studies and clinical trials in resource-poor areas and outbreak situations with advanced statistical methods, and evaluating the best ways to bring effective measures to the people;
- to analyse the impact of an ever-evolving environment of infections spread and changing burden of infectious diseases and long-term effects of infections to improve health;
- to develop and implement training and capacity-building measures within the framework of international cooperation that equip communities, researchers, and institutions alike.

Our vision is to gain a deeper, science-driven understanding of infectious agents and diseases. This knowledge is critical to designing effective, sustainable control measures, particularly in low-resource settings. We are committed to advancing tropical medicine through state-of-the-art techniques, modern digital tools and global interdisciplinary collaborations.

We believe that lasting progress is only possible through strong, equitable partnerships. Our vision is a global network of collaborative, empowered institutions united by a common goal: to reduce the burden of infectious diseases worldwide through innovation, scientific excellence, and shared commitment.

III. BNITM STRATEGY 2030 – GOALS



What makes pathogens harmful?

1. Explore pathogens

Systems, cell and structural biology with state-of-the-art technology

We are committed to advancing basic research on tropical and emerging pathogens through a truly comprehensive, systems-based approach. We strive to identify pathogen vulnerabilities to guide the development of more effective vaccine and treatment strategies to combat them. Consequently, we study pathogens in the context of their complex interactions with vectors, human hosts, and reservoir animals - exploring everything from molecular mechanisms to cellular and systemic responses.

We combine molecular and cell biology as well as biochemistry with omics approaches, bioinformatics and AI-powered computational methods to explore pathogens in unprecedented depth. By using innovative experimental techniques and integrating different approaches, we uncover how pathogens replicate and affect host cell processes.

We are growing our internationally recognised research teams and launching new groups dedicated to systems-level and computational research. Long-standing partnerships with renowned institutions worldwide enable this excellent basic research.

These efforts are supported by exceptional infrastructures: we work at the highest biosafety levels to study dangerous pathogens, develop accurate animal models and alternative approaches, rear vector mosquitoes, and conduct complex infection experiments. Our expanding role at the Science City Bahrenfeld including the Centre for Structural Systems Biology (CSSB) ensures access to some of the most advanced imaging technologies.

How do infections make people sick?

2. Explaining disease

Unraveling biological processes during infection

Why do some people stay symptom-free during infections while others face life-threatening complications? How is it that some people experience long-term effects after infections (e.g. post-COVID) or have an increased risk of reinfection (post-malaria)? The reasons behind these very different outcomes are often unknown.

Using state-of-the-art technologies in clinical infectiology, immunology, and molecular and cellular biology, we investigate how pathogens interact with the human body at every level - from single cells to whole organ systems. To understand these complex processes under conditions that closely mimic real world infections, we combine experimental data with modern modelling techniques, bioinformatics, and systems biology to get a comprehensive picture of how disease unfolds.

Our focus is on understanding these complex processes. We analyse immune responses in human studies and, where appropriate, in experimental models, including multi-organ-on-a-chip systems with integrated immune compartments. We concentrate on understanding how infections – especially emerging ones, which are often poorly understood – disrupt the delicate balance of cell and organ functions, with the aim of enabling the development of more effective interventions.

While much of our work investigates the pathophysiology of severe illness, we also study the mechanisms by which protective immune responses develop - or fail to develop - during natural infections and following vaccination. In many tropical diseases, both naturally acquired and vaccine-induced immunity tend to emerge slowly and incompletely. Understanding the underlying causes of this phenomenon is essential for the strategic improvement of vaccine strategies.

By integrating this data through systems biology, we uncover how infections unfold and how the body responds. Using innovative experimental techniques - from precision genome editing to next-generation infection models like organoids - we explore infection processes in ways that connect molecular insights to real clinical outcomes. By identifying critical turning points, we aim to develop targeted strategies that can intercept disease pathology and poor vaccine immunity.

How and why do infections occur?

3. Understand infection

Analysing and modelling infections with tropical and emerging pathogens

A focus of our work is to prevent and fight infections through state-of-the-art epidemiological, ecological and immunological research. The main focus is on infections that affect population groups in resource-poor regions. For epidemiological analyses digital innovations like artificial intelligence for data collection and interpretation are applied. We rely on advanced modelling, big data analytics, and high-resolution satellite imagery to investigate how infections spread and how antimicrobial resistance (AMR) emerges and evolves.

Our expertise in parasitology, entomology and virology is supported by exceptional laboratory infrastructures, including a state-of-the-art biosafety insectary, in Hamburg. Here and in the affected countries, we study how vectors carry and spread pathogens - like mosquitoes transmitting dengue or chikungunya virus. These analyses are essential for identifying conditions under which infections occur and for designing effective strategies to prevent and interrupt transmission. In particular, the influence of climatic variability on the spread of infections is to be analysed in collaboration with climate researchers.

Successful control measures, environmental changes and human behaviour influence the epidemiology of infectious diseases. We therefore want to develop and establish methods for informative surveillance that reliably and continuously records infection dynamics, even in resource-limited regions. We adapt our research and interventions to changing epidemiological realities.

Looking ahead, we are intensifying our efforts for populations under increased risk to infectious diseases. Using mobile laboratories, we carry out risk analyses and field studies in remote and underserved areas. With the support of modern data science, we analyse infection dynamics and model risk patterns for outbreaks. These activities contribute to the development of predictive models and early warning systems that take into account infectious agents in humans, animals and the environment (One Health). The data is collected and stored under conditions that enable artificial intelligence models to be trained.


Nikon
JAPAN

Who is infected – and with what?

4. Detecting diseases

Robust diagnostics for established and emerging pathogens

Accurate and modern diagnostics form the basis for effective clinical care, meaningful epidemiological research and for the fight against poverty-related and neglected diseases.

We therefore offer one of the most comprehensive diagnostic portfolios for tropical diseases in Europe. As Germany's National Reference Centre for Tropical Pathogens and a WHO Collaborating Centre for Arbovirus and Hemorrhagic Fever Reference and Research, we detect and monitor an ever-growing array of pathogens. We plan to establish additional reference units such as a WHO Collaborating Centre for Schistosomiasis Reference and Research. We aim to continuously improve the quality of our diagnostics by redesigning tests and developing and evaluating new assays for emerging and neglected pathogens.

Metagenomic sequencing will play an important role in BNITM's future diagnostics, enabling rapid, unbiased detection of known and emerging tropical pathogens across humans, animals, and the environment. By integrating it into routine surveillance and fast outbreak response, BNITM can strengthen its role as a global reference centre while driving innovation in infectious disease research.

Recent outbreaks have highlighted the critical importance of timely responses enabled by readily available diagnostics. To address this, we are developing innovative diagnostic tools, including tests specifically designed for use in low-resource settings, deploying mobile laboratories for rapid diagnostics in outbreaks worldwide and supporting the establishment of sustainable diagnostic capacities within affected countries.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How can control measures be applied most effectively?

5. Improving control

Bridging the gap between innovation and impact

Vaccines, therapeutics or other interventions already exist for many tropical infectious diseases, but far too often, they don't reach the people who need them most. Collaborative research of multiple disciplines showing how scientific evidence can be put into practice is often neglected but urgently needed. We share the WHO's view that implementation research is crucial for ensuring that medical breakthroughs lead to enduring change.

At BNITM, we focus on controlling and eliminating poverty-related and neglected diseases in resource-limited settings by fostering inter- and transdisciplinary collaboration across medicine, biology, economics, anthropology, psychology, and computational science. We examine the social, economic and environmental factors affecting health outcomes - tracking mobility and behaviour, testing interventions, and leveraging computational modelling. We are a WHO Collaborating Centre for Behavioural Research in Global Health, positioning us at the forefront of this critical work.

We know that for control measures to succeed, they need to build on the trust of the communities they are meant to protect. Hence, we work hand-in-hand with local partners and communities to explore how solutions are culturally grounded, context-specific, and integrated into local health systems. In our research, communities participate at the earliest possible stage of implementation: from co-developing guidelines for treatment and diagnosis to co-designing innovative surveillance tools and early warning systems with the aim of empowering communities to act quickly and effectively.

To make real progress, we are strengthening our long-term, sustainable partnerships in the Global South - built on mutual trust, knowledge sharing, and joint innovation. We value cultural and societal contexts and traditional knowledge. That is why we are expanding our network of interdisciplinary and international collaborations, deepening ties with organisations like the WHO.

Which medicines and vaccines are (most) effective?

6. Develop medicines

Searching for new interventions: Vaccines and medicines that make a difference

There is an urgent need for new and effective tools to prevent and treat diseases that affect people in low- and middle-income countries (LMICs). At BNITM, we are actively developing and testing innovative therapeutic and prophylactic strategies - starting at the molecular level and progressing through model systems, preclinical testing and clinical trials to evaluate the applicability of interventions.

Testing novel drugs and vaccines in clinical trials is a vital step to improve the treatment and prevention of infectious diseases. We plan to integrate digital solutions like computer-based simulations and artificial intelligence to identify promising drug and vaccine candidates and streamline their development. In the future, natural substances will be explored to identify bioactive compounds inspired by traditional application of medicinal plants and use of plants by animals for self-healing. At the Centre for Structural Systems Biology (CSSB), high-resolution molecular imaging techniques of critical molecules will be applied to identify potential targets for drug and vaccine candidates. Our research on pathophysiology paves the way for intervention studies by identifying addressable pathways and mechanisms.

Clinical research plays a vital role in turning scientific discoveries into real-world health solutions. Yet, due to limited commercial incentives, the pharmaceutical industry often overlooks diseases that mainly affect LMICs. To accelerate development, we will deepen internal collaboration across disciplines - especially with our teams in diagnostics and implementation research - to conduct large-scale intervention studies for promising therapeutic and preventive substances. One of our key goals is to establish BNITM as a leading centre for the clinical development of evidence-based interventions in tropical medicine, including vaccines, treatments, and prevention strategies.

We plan to expand clinical and research infrastructures - both in Hamburg and at our long-standing partner sites in Ghana, Gabon, and Nigeria - into full-service platforms with modern facilities, rigorous quality management, expert teams, and advanced training programmes. This will enable us to carry out clinical studies in line with the highest international standards.


BASIC RESEARCH
PRECLINICAL RESEARCH
CLINICAL TRIALS
PRODUCT LICENSING
IMPLEMENTATION
APPLICATION

How can we enable effective research in the tropics?

7. Strengthen research capacities

Tailored education and digital training innovation

We are committed to working closely with our partners in countries affected by poverty-related and neglected diseases (PRNDs) to strengthen all aspects of health-related research, from prevention and diagnostics to care and disease control. We focus on creating long-term impact by establishing robust infrastructures, securing essential equipment and resources, and investing in the training of skilled professionals.

True partnership lies at the heart of our approach. We collaborate and communicate respectfully with local institutions, communities, and experts, valuing cultural sensitivity, traditional knowledge, shared learning, and joint decision-making. Our partnerships are built on bidirectional transfer of knowledge and experience, ensuring mutual growth and understanding. Through mobile labs, immersive training, and close collaboration, we help foster scientific autonomy and contribute to fairer health systems. As part of this mission, we intend to extend the European Mobile Lab network and to establish an African Digital One Health Centre.

Training and education form a central pillar of our capacity-building efforts. Drawing on our partnerships with low- and middle-income countries, we design practical, interdisciplinary programmes for students, postgraduates, researchers, clinicians, and technical staff. These programmes are designed to enhance individual expertise. They also promote international exchange and long-term local capacity in research and healthcare, both in Germany and abroad.

Looking ahead, we plan to strengthen and expand our internationally recognised training portfolio. This will include more in-person and online courses funded by external partners, as well as innovative digital formats such as virtual reality modules and interactive tools.

To maximise our impact, we are working toward accreditation of many of our programmes through global education networks. Our vision is to improve training through virtual 3D simulations, mobile phone apps, digital case scenarios and gamification approaches, especially in biosafety, diagnostics, clinical medicine, disease control, as well as epidemic preparedness and response.

How can we treat patients in the best possible way?

8. Improve care

Excellence in tropical and travel medicine

With increasing mobility and migration, the demand for high-quality tropical and travel medicine is also growing. Due to the rising spread of pathogens, management of patients with emerging infectious diseases becomes more important. We are committed to expanding our clinical capabilities and deepening our impact - both in Germany and in the Global South - to meet these growing needs. We will bridge research and practice - transforming clinical findings into practicable interventions that improve outcomes for patients worldwide.

A cornerstone of this effort is our close collaboration with the Division of Tropical Medicine at the University Medical Center Hamburg-Eppendorf (UKE). Together, we deliver patient care and clinical support to provide expert management of highly infectious diseases. Our goal is to strengthen Hamburg's role as a leading clinical centre for tropical diseases. We provide expertise to improve medical care for viral hemorrhagic fevers (VHF) - also during outbreak situations. We support response mechanisms from the WHO, EU, and German institutions, and we contribute directly to global epidemic preparedness.

In addition to patient care, we increase our focus on prevention of infectious diseases by provision of travel medicine services, continued clinical research to develop new preventive tools and by teaching state-of-the-art practices in travel medicine. By strengthening diagnostic excellence and deploying innovative mobile labs, we are transforming patient care and enabling faster, more effective responses to disease outbreaks.

To further extend our reach, we are establishing specialised outpatient clinics and enhancing our national consulting services, offering expert guidance to healthcare professionals across Germany. We also aim to accelerate the translation of clinical research into guidelines - also for those working in resource-limited settings.

Through international partnerships, we are creating opportunities for clinical training and specialisation in tropical medicine and infectious diseases for medical students and doctors from Germany and the Global South. These programmes are designed to train the next generation of clinicians and researchers. We are committed to strengthening health systems in the Global South by delivering better care and disease management to communities.

IV. OUR GUIDELINES

1. Excellent research

A key mission of the BNITM is to conduct high-quality research in the field of tropical medicine and global infections. Our research spans the translational spectrum of infectious diseases: from the structure and biology of pathogens, their animal reservoirs, and the transmission vectors, to the complex factors that drive disease progression and transmission. We investigate aspects ranging from clinical care and treatment to epidemiology, individual prevention, and public health interventions. Integrating computational sciences allows us to model, predict, and optimise interventions with greater precision. We place growing emphasis on improving strategies to combat tropical infectious diseases everywhere in the world - to ensure solutions are effective and sustainable in diverse contexts. This is supported through events, teaching, training and further education as well as providing expert advice and care in infectious and tropical medicine locally and worldwide.

An essential part of this work is our commitment to using the best scientific, technological, and institutional infrastructures. We prioritise continuous internal and external quality control, regularly refining and adjusting our research focuses and methodologies. Ongoing optimisation of our infrastructure, systems, processes and overall quality of our work is essential to us.

2. Cooperation worldwide

We maintain close, reliable partnerships with national and international research institutions and organisations, placing particular value on collaborations that ensure sustainable success for all parties involved. We adopt inter- and transdisciplinary approaches, viewing cooperation as a key pillar of our success. Through these partnerships, we continue to strengthen our expertise in research and diagnostics. The rapid and professional worldwide response to epidemics is a core component of our operational approach.

We employ diversified strategies to develop and test innovative control measures for infectious diseases. We are committed to conducting research directly in the affected countries, working closely with local partners, and supporting this through training and the development of research infrastructures (capacity building). We leverage a global alumni network of former employees and participants from our training programmes and courses. This network improves cooperation and increases the visibility of our institute as a whole.

3. United for goals in the Hamburg region

We are committed to fostering a strong regional research environment through close collaboration with local institutions and attracting leading scientists through competitive selection processes – further

reinforcing Hamburg's reputation as the "Gateway to the World". By providing access to key research infrastructure, we help strengthen the region's position as a hub for infection research.

The renovation and expansion of BNITM's buildings are critical for sustaining its unique expertise and services. This strategic growth will enhance collaboration with local and global partners, deepen ties within Hamburg's research landscape, and ensure the institute remains equipped to address future infectious disease challenges. As a so-called 'vital facility' in Hamburg, we provide with our biosafety laboratories the essential civil protection infrastructure to achieve this mission.

Collaborative teamwork at BNITM plays a key role in our success. We nurture this by promoting internal cooperations, offering opportunities for regular scientific exchange and setting goals together.

4. Sharing knowledge

Our goal is clear: We aim to conduct impactful and excellent research. Our scientific data and findings are transparent and freely accessible for scientists as well as the public. We are convinced this provides an invaluable opportunity to fully harness the potential of our findings. Additionally, we maintain productive connections with industrial and academic partners, healthcare providers and local stakeholders to ensure that the knowledge we generate is utilised effectively and translated into useful applications and therapeutics.

We contribute research-based knowledge to inform public discourse and political decision-making, while actively engaging with society through clear science communication, outreach activities, and public events. By offering expert advice and specialised diagnostics - including for rare, emerging, and neglected infectious diseases - we support local health protection and help build trust between science and society. Training programmes and courses further strengthen this knowledge transfer, equipping professionals with the tools to understand and respond to infectious disease challenges. These efforts contribute to greater public awareness and strengthen health protection.

5. Succeed together

To achieve our ambitious goals, we rely on the dedication and motivation of everyone at BNITM. We envision an institute where everybody is empowered to contribute to the institute's development. To realise this, we aim to create an environment that enables all staff to reach their potential through training, personalised support, and the cultivation of conditions that foster success.

We recognise that balancing professional and personal responsibilities can present unique challenges, and we strive to offer support to meet those needs. At BNITM, we believe that both science and society thrive on diversity, and we are deeply committed to the principles of equity, inclusion, and international collaboration.

In response to the growing shortage of skilled professionals, we are pursuing proactive recruitment strategies and continuously evolving our leadership culture to better support students and early-career scientists in preparing for diverse career paths - within science and beyond.

To create even more efficient conditions for research on infectious diseas-

es at BNITM, we aim to provide modern infrastructures, efficient and responsive administration, lean bureaucratic processes, financial stability and transparent communication.

6. Setting ethical standards

Our research is dedicated to serving human and peaceful purposes and we are committed to the privilege of scientific freedom. Through our work, we align ourselves with the UN Sustainable Development Goals. We respect the rights of countries and patients to their biological resources and are dedicated to minimising possible negative impacts of our research on individuals, society and the environment.

While animal experiments remain essential in certain areas of our research, we are committed to keeping it to a minimum. This includes reducing the use of animals, continually improving research techniques to minimise stress on the animals, and advancing alternative methods.

We view our long-standing history and good reputation as both a privilege and a responsibility. We recognise the colonial history of the institute and are determined to contextualise and critically engage with it.

Strategy in transition

We conduct research in a rapidly changing world shaped by population growth, climate change, technological advancements as well as social and political dynamics. We remain resilient and grounded in our core values, aligning our efforts with broader global commitments and policies. We regularly refine our research strategy - not in response to passing trends, but to stay true to our mission and to ensure meaningful, sustained progress toward our goals.

Global health forms the foundation for economic development, social justice and peace. This understanding drives us forward.

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